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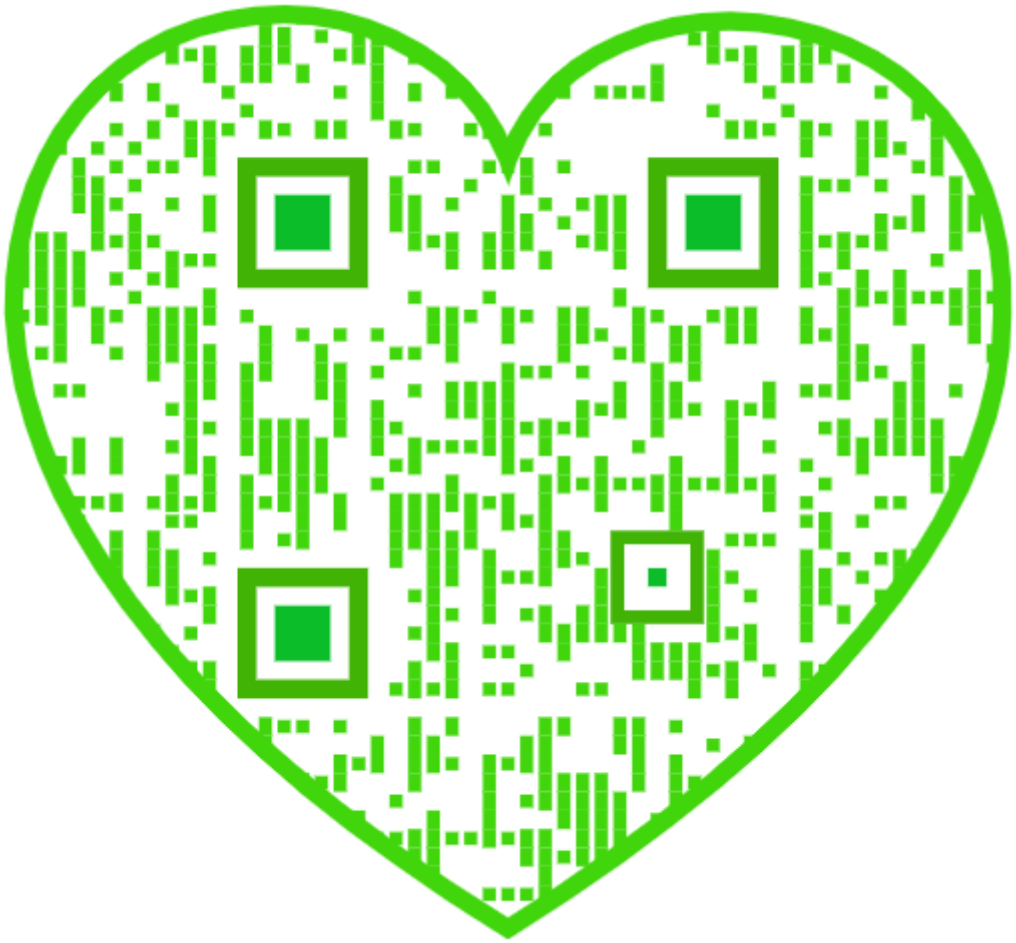

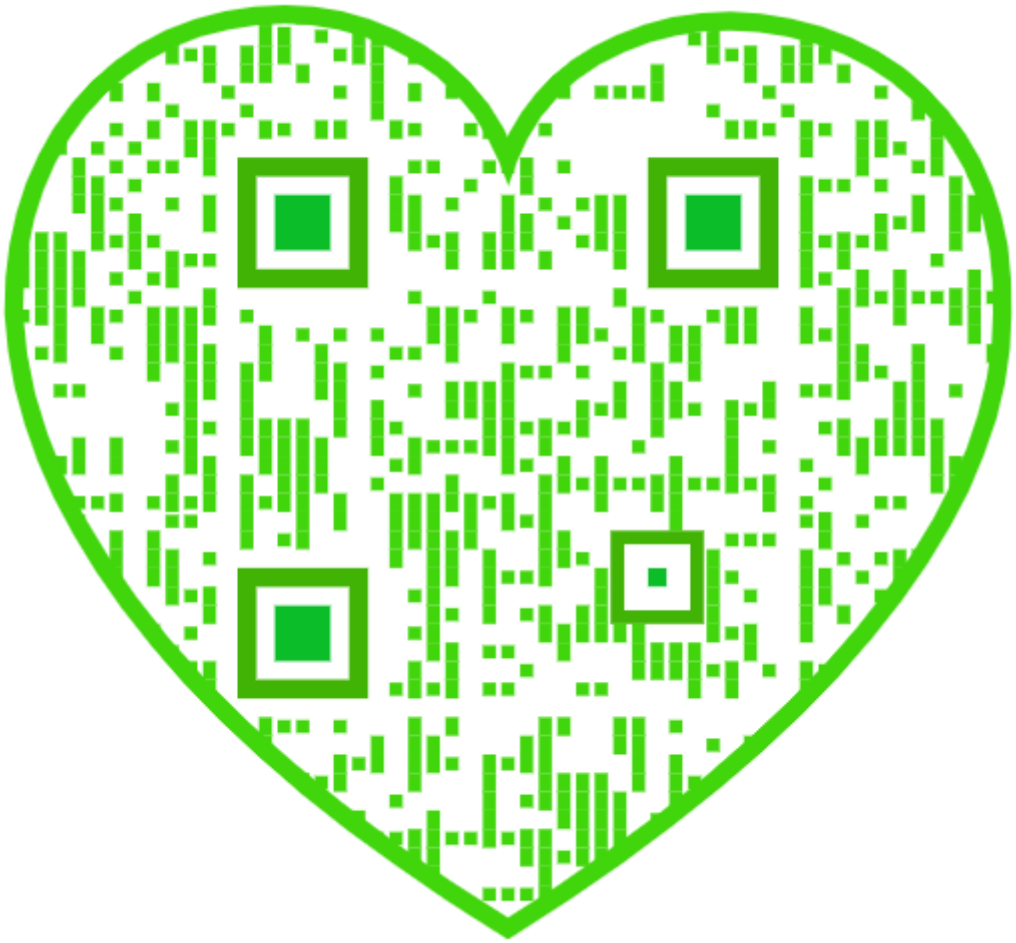

The Trial Case and How to Use It

LOCKWOOD

The Trial Case and How to Use It

A Practical Treatise For Optometrists

Illustrated
Second Edition

By
R. M. LOCKWOOD
Author of Principles of Optometry, Some Experiments in Optics, Subjective Tests for Difficult Cases, Etc.

NEW YORK
FREDERICK BOGER PUB. CO.
1 Maiden Lane

OPTOMETRY

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Frederick Boger Pub. Co.
1 Maiden Lane
New York

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The Optical Journal

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PREFACE TO THE SECOND EDITION.

The very cordial reception which has been accorded to this work whereby the first edition becomes exhausted in six months, is extremely gratifying to the author, who feels that the series of practical works of which the present volume is the second really fills a want among those who make eye testing a profession. He feared that optometrists might not care to freshen up on the details of their work, but the result has proved this not to be true. In the first volume of the series, "Principles of Optometry," he presented the principles as against the science of optometry; in the present volume he gives the routine practice for ordinary cases as he follows it, while in "Subjective Tests for Difficult Cases" he presents a great many practical methods for those cases where the routine method is undesirable or where a re-examination is necessary.

The author has carefully prepared the text of this second edition. He has made a few corrections and slight additions to give greater clearness, but otherwise the work remains the same as in the first edition.

CHAPTER I.

THE EYE AND SOME OF ITS FUNCTIONS.

THE EYE.—The eye is the same as a photographic camera so far as its image-producing power is concerned, and corresponds to a lens of something less than an inch focus. It differs from a camera in the fact that it is not a simple lens or a combination of simple lenses forming an image in the air at a certain distance to the rear, but rather a succession of transparent refracting living substances forming altogether one solid whole. Commencing at the front is the cornea, the transparent portion of the eye which is exposed to the outside world. Behind this comes the aqueous chamber, so called because of the watery-like fluid which it contains; next the crystalline lens, which is bi-convex in form, then the vitreous, a jelly-like, transparent medium, and finally the retina, or the screen of the eye, on which the image made by the succession of transparent bodies just specified forms a copy of external objects. The retina is really an expansion of the optic nerve which consists of hundreds of thousands of individual fibres, entering the ball of the eye from the rear and then spreading out on the inner surface of its hindermost portion to form the retinal screen. This retinal screen is very complex; is made up of nine distinct layers, all transparent, but the deepest one of all considered to contain those peculiar organs, the rods and cones, which are now supposed to fulfill the function of responding to the waves of light in such a way that the vibrations which they transmit to the fibers of the optic nerve are carried by

the latter to the visual centers of the brain, there to be interpreted in that mysterious way which we call vision.

The eye is a globe, or almost one, of a diameter of about one

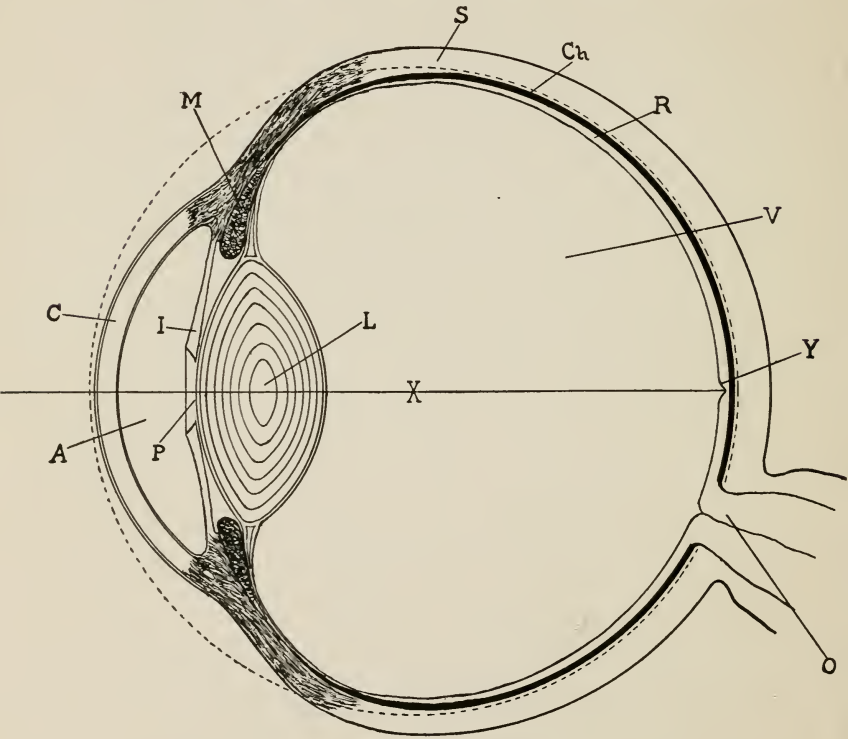

FIGURE 1.—THE EYE.

S.—The sclerotic.
V.—The vitreous humor.
Ch.—The choroid.
Y.—The macula lutea.
A.—The aqueous humor.
I.—Iris.
L.—The crystalline lens.
M.—The ciliary muscle.
R.—The retina.
O.—Optic nerve.
C.—The cornea.
P.—The pupil.
X.—The centre of rotation of the eye.
The dotted circle shows the departure of the normal eye from a spherical form

inch. Its outer coat is very tough, far more so than it looks, and this outer coat consists of three distinct layers. The inner one, the retina, has already been referred to. Next to and outside of it is the choroid, which is thin and dark purple, and contains most of the blood vessels which feed the eye and carry off the products of decay, for the eye is a physiological instrument and like all the other organs of the body it is continually wearing out and being renewed, or in other words there is a continual circulatory current in the eye, and in all parts of the eye, which constantly brings in new food and carries away waste products. It is true that it is all transparent, or rather so in health, but at the same time this circulation is absolutely necessary, and its cessation for any reason means blindness in a few hours, while a partial choking up of the ducts is very apt to seriously interfere with vision and ultimately destroy it. Immediately outside of the choroid is the sclerotic coat, which is white and very tough. At the front of the eye this coating becomes transparent and then is known as the cornea.

In the center of the cornea is the pupil, which is merely the central portion not covered by the iris. It looks black, but is really transparent. The reason we cannot see through it ordinarily is that to see anything through a transparent substance there must be something more or less lighted up behind it, but in the case of the eye the only way for the retina to be lighted up is through the pupil, and this will never occur so long as our head is in the way of the light, which it will always be when we attempt to look inside. By reflecting light into the eye from a mirror, in the center of which there is a tiny hole, through which we look, we will then see the back of the eye, and the pupil will appear bright red, or orange, instead of black, this due to the capillary

network of blood vessels of the choroid showing through the transparent retina.

The eye is subject to many diseases, with very few of which the optometrist can have any concern. The main thing that he should know in this connection is to detect opacities, whether due to cataract or to some other cause; and to be able to tell by simple inspection whether there is anything abnormal in the visible portions of the eye. For this purpose a condensing lens, the concave mirror and the ophthalmoscope are used.

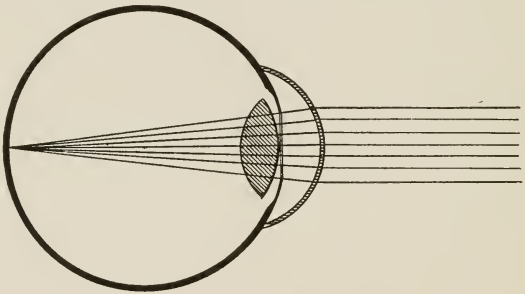

FIG. 2.—A NORMAL EYE.
One in which parallel rays of light focus on the retina when the eye is in a state of physiological rest.

A NORMAL EYE.—From the point of view of the optometrist a normal eye is one which when it is in a state of physiologic rest it can look upon far distant objects and see them distinctly; that is, the image of the distant object formed on the retina will be without the slightest diffuseness of image. Such an eye is extremely rare, but it serves as a standard of comparison by which we may express the dioptric condition of any eye which is under test. Such an eye is said to be emmetropic. When the eye is abnormal from an optical point of view we call it ametropic.

It is the sphere of optometry to supply glasses to ametropic eyes to bring them as near to emmetropia as the physiological and optical conditions will permit.

ACCOMMODATION.—Just back of the iris where it meets the sclerotic is a small circular muscle attached to a membrane, to the center of which is fastened the crystalline lens. Although the eye is a camera, there is one important point in which it differs from all others cameras. Its screen is fixed, and in order to see distinctly for all distances it must change its magnifying power. With an ordinary lens, the nearer the bright object on one side of the lens, the farther away must be the image on the other side of the lens, but with the eye there can be no movement of the screen which receives the image, hence the power of the lens itself is altered. The more the crystalline lens swells in the center the greater its strength, and the greater its strength the nearer the object must be to be seen distinctly. It is the function of the small circular muscle to produce these changes in convexity by loosening up the membrane, so that as this loosening occurs the crystalline lens swells. This property of the eye is called its accommodation. It is strongest in childhood, but steadily diminishes in power as we grow older until at about 65 years of age there is no more accommodation, and the eye is only in focus for just one point. This ocular process is called presbyopia and all human beings without exception, are subject to it. As a result of it all persons, except a few very near-sighted ones, must wear glasses eventually to read, while others must also wear glasses to see well at a distance.

FAR AND NEAR POINTS.—These are the two points which express the limits of the accommodative power of the

individual. In the case of a myope they have an actual existence, and the same is the case with an emmetrope. In the former case the two points will be within infinity, one being the greatest distance at which the eye can see clearly and the other the nearest point at which it can see clearly. In the case of the emmetrope one will be at infinity, but with a hypermetrope only one of the points, the near point, can have an actual existence, and where the hypermetropia is high both points may be beyond infinity; that is to say, they will have no actual existence, the eye not being able to focus any rays on the retina whether near or far. In this case they may be said optically to be behind the patient's back.

HYPERMETROPIA.—When the eyeball is deficient in depth, or the dioptric power of the crystalline lens of the eye is too low, then we have a condition called hypermetropia or hyperopia. In this ocular condition the ciliary muscle must act to increase the power of the crystalline lens so that the image of the distant object instead of blurring on the retina may form there a clear and distinct image. This puts a great deal of work on the delicate ciliary muscle as compared with that of the emmetropic eye, in which there is no strain at all on this muscle. The possible results of this condition are several. First the eye will show presbyopia before it would were the eye strictly normal. Usually with the normal eye, glasses are needed for reading about 42 years of age, but with an eye which is hypermetropic to a high degree this necessity may arise many years sooner, while in some extra high cases the glasses are needed in childhood. The average eye has just about so much ciliary power, and if, as is the case with a hypermetropic eye, half of this is used to overcome the optical abnormality of the eye, then only half of it is left for a

reserve, which will of course be used up long before the traditional age of 42. The second difficulty which arises with hypermetropic eyes is headache and eyestrain. Each individual has a certain amount of nervous force, and while there are some who can give up the amount demanded by the ciliary muscle in hypermetropia, there are others which even with a very small amount of it will suffer from headache, especially after sightseeing, as well as from eyestrain, and in some extraordinary cases from several remote nervous reflexes. Finally the ciliary muscle may take on a condition of "spasm" or "cramp," in which as the result of overwork the muscle may suddenly contract into a fixed position and simulate myopia. There is considerable difference of opinion as to the nature of this spasmodic condition, some claiming that it a persistent spasm hard to break up, others that it is only effective when the eye is in use, and that by "fogging" the spasm will relax. Tscherning dismisses the whole subject with the statement that "all spasm of the accommodation will relax promptly in the dark room." If this is true then certainly "fogging" is all that is necessary. In any event the optometrist must be constantly on his guard not to be deceived and prescribe the wrong lenses.

MYOPIA.—When the eyeball is too long, or the dioptric power of the crystalline lens of the eye is too strong, then we have a condition of myopia. In order that the image of a given object shall come clear on the retina, the power of the crystalline lens must weaken, but there is a limit to this, which is reached when the ciliary muscle is entirely relaxed. Myopes cannot see at a distance, but do not have to wear reading glasses so soon as emmetropes and hypermetropes; in fact, some of them never have

to wear them. For a normal eye in a young person the range of vision may be from 6 inches to infinity, while in a myope it may only be from 4 to 13 inches. In both case the eyes have about equal accommodative powers. It was laid down by Donders, and many others hold the same opinion, that a myopic eye is always a diseased eye, and that the myopia is usually progressive and is due to civilization; that eyes were not meant for such close work

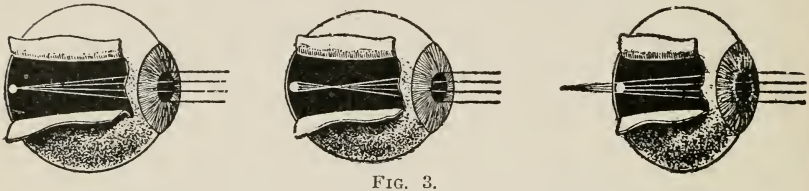

FIG. 3.

(*a*) Emmetropic eye. (*b*) Myopic eye. (*c*) Hypermetropic eye.

as is common in schools, though of late years this opinion given out by Donders has been somewhat modified. It is now held that there are two sorts of myopia; one, non-malignant, which is the result of school life, and which runs to a certain point and there stops, and the other the true malignant variety, which has nothing to do with school. Germany is the home of the myope and the condition arouses much concern there.

ASTIGMATISM.—The eye is far from being optically perfect and one of its most common defects, found alike in emmetropia and ametropia, is astigmatism. This means that ocular condition in which the different meridians of the eye have not the same power. If we put before such an eye a narrow slit, first vertical, then horizontal, and then in several other different directions, we will find one direction in which it shows a greater power than the others, and we will find another in which the power is

less than all the others. The two directions, one having the strongest power and the other having the least, are the two principal meridians of the eye. Before we can get the clearest image possible on the retina we must make all the meridians of equal power. Astigmatism is extremely common, but in most cases of so little amount that the owner has become used to it, and in fact is better satisfied with it uncorrected than the contrary, but where the condition is at all marked it often gives rise to the same symptoms as hypermetropia and is accompanied with poor vision.

USE OF CORRECTING LENSES.—The lenses used for the correction of hypermetropia are those which, by adding dioptric power to the eye, force the ciliary muscle to give up an equal amount, and thus bring about a normal state of rest. These are plus lenses, those which have a magnifying power. For myopia minus lenses are given, those which have a minifying power. Their effect is to so decrease the total dioptric power of the eye and lens together that the images of distant objects will come clear upon the retina. For astigmatism we must use cylinders, either plus or minus, as the case may require. These are lenses having their curvatures all in one direction. If a plus cylinder is used its greatest power is so placed that it corresponds with the weakest meridian of the eye and thereby makes the two meridians equal, or else if a minus lens, its greatest power is placed at right angles to the highest meridian of the eye, or what is the same thing, parallel and coincident with the meridian of lowest power. The result in either case is the same; all the meridians are made alike and the combination acts as a sphere. For compound troubles, such as hypermetropia combined with astigmatism, we must give a cylinder combined with a sphere. These form what are called spherocylinders.

The retinal image of an astigmatic eye is not correct but for one meridian at a time, and advantage is taken of this in testing for astigmatism. The eye under test is fogged, that is, a plus lens is placed in front of it which blurs distant object. Then the patient is directed to look at a set of black radiating lines, of which he will see those in one direction the best. This direction is one of the principal meridians of his astigmatism. The other is at right angles to it. The direction of a cylinder in which there is no power is called its axis.

PRISMS.—Prisms, though having no magnifying power, are usually included under the general name "lenses" when all the transparent media employed in the correction of refraction are considered together. They are used in some cases of heterophoria, where this cannot be dissipated by the correction of the ametropia, or where the case is not severe enough to demand an ocular operation.

DIOPTRIC SYSTEM.—Lenses are now numbered as follows: A lens forming on a screen an image of the sun at a distance of 40 inches is of 1 diopter; a lens twice as strong, or one forming an image of the sun at 20 inches is a 2 diopter lens; a lens which is three times as strong, forming an image of the sun at 13 inches, is a 3 diopter lens, etc. The lenses in the trial case are numbered in this way. To find the value of two or more of them together combine the values as shown on their handles. The old system was based on French inches, which are not exactly the same as English inches, but one system may be turned into the other, accurately enough for all practical purposes, by the following rule: To change from diopters to inch system divide

40 by the value in diopters and the quotient will be the value in the inch system. To change from the inch system to the dioptric method divide the number in inches into 40, and the quotient will be the corresponding value in diopters. The reason we use 40 is that the dioptric system is based on the meter which is 39.37 inches, and 40 is so close to this that it is universally used.

AMBLYOPIA.—This means poor vision due to physiological or pathological reasons; something wrong with the retina, the optic nerve or the visual brain centers. It cannot be corrected by lenses during the test.

EXTERNAL MUSCLES OF THE EYE.—These are six in number, four pulling the eye (lightly) back against the capsule in which it rests, and two others acting with the check ligaments to pull the eye forward, thus keeping the organ in a state of equilibrium. These muscles act harmoniously together, so that in a normally functioning eye it may take any position required for good vision with correctness and ease. Where this is not the case, then we have a condition of heterophoria or muscle imbalance which may result in headaches, eyeaches or other disagreable symptoms; or else the eye may give up the struggle and squint. Heterophoria is difficult to treat; prisms, muscle exercises and operations being the means used.

ASTHENOPIA.—This may be of two kinds, muscular or accommodative. In the first case there is strain on the external muscles of the eye; in the latter it is strain upon the ciliary muscle. In either case the symptoms are about the same; eyeache, difficulties with vision, and sometimes nervous affections, more or

less hard to discover and cure, whose connection with the eyes is hard to trace. Usually lenses and cylinders properly applied in spectacles will correct accommodative asthenopia, while for the muscular form we must have recourse to prisms, muscle exercises, or even operations.

PHOTOPHOBIA.—This is an intolerance of light, more or less pronounced. It may be due to sluggishness of the iris, undue sensitiveness or inflammation of the retina, and is common in albinos, or where the eyes have been subjected to a dazzling light, as well as in diseased conditions. It is properly a case for the oculist, though tinted glasses are sometimes prescribed by the optometrist to rest the retina. Only smoked glasses should be prescribed for this purpose.

CHAPTER II.

TESTING AND MEANS EMPLOYED.

METHODS OF TESTING.—There are two general methods of testing eyes, the subjective and the objective. In the former we depend upon what the patient says in response to our questions as we apply our various tests. In the latter we judge for ourselves by what we actually see. Both methods have their place in optometry, but the subjective test with the trial case is always the court of last resort, and everything is checked up by it.

TEST TYPE FOR DISTANCE.—Twenty feet has come to be the standard distance for testing eyes for all uses except near work. The rays of light coming from this distance are so nearly parallel that the slight error is disregarded. The letters on the chart are usually black on a white ground, and figured for definite distances, the distance for which the different sizes are calculated being marked above each line. These types may be used at less than the regular distance of twenty feet, but in this case allowance must be made for the decrease in distance. With these types we are able to express the visual acuity either with lenses or without. In doing this we make use of the fractional method, the numerator being the distance of the type and the denominator the size. A child, corrected, if necessary, with lenses, should have a visual acuity of 20/15; an adult under the same circumstances 20/20; an elderly person 15/20. Where this result cannot be reached, the eye is below normal. Sometimes a better re-

sult can be obtained, and in this case the eye is above normal, but these cases are somewhat rare.

TEST TYPE FOR NEAR.—There are two varieties of this type, one Jaeger's, which is nothing more than ordinary type from the printer's font graded from the very finest up, and the other Snellen's, which is similar to the distance type, but decreased pro-

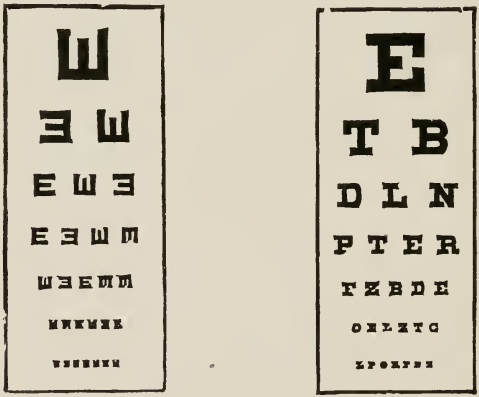

FIG. 4.—Test Types.

portionately in size to correspond with the short distances at which it is used. With this type we find the reading point and the acuity of vision for a short distance. Normal eyes should read the very finest type on the chart at a distance of 13 inches. Many eyes can do even better than this when properly corrected with glasses. This chart may also be used in finding the amplitude of the accommodation.

CLOCK DIAL CHART.—This consists of a series of radiating lines with outer circles and Roman numbers arranged to correspond closely with the dial of a clock. It is used in connection with cylinders for the detection and correction of astigmatism.

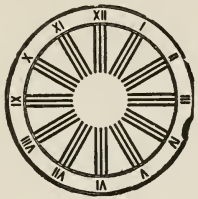

Fig. 5.—Clock Dial Chart.

The Roman figures are used to name the radiating lines, those which are vertical being called the XII to VI lines; those which are horizontal being called the lines from IX to III, etc. The values of the lines are sometimes also read off in degrees; the IX

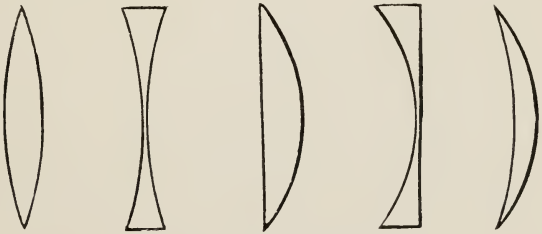

Fig. 6.—Types of Lenses.

being zero, X 30, XI 60, XII 90, I 120, II 150, and III 180. This numbering is in the contrary direction from that of the trial frame. but this is necessary to make the two agree, since they are used facing in different directions. There are many other line-tests for astigmatism, but they are all based on the same principle.

PLUS LENSES.—These are magnifying glasses. They converge the rays of light, and if the object is far enough away, they will bring all the rays of light from this object to a focus, where they will form an image, a duplicate of the object in form and color, but inverted. In the trial case there are many of these plus lenses arranged on the dioptric system and graded from the weakest to the strongest. Their values are marked on the handles, the fact that they are plus being shown by a cross stamped in the metal.

MINUS LENSES.—These are minifying glasses. They diverge the rays of light, and do not form an image of the illu-

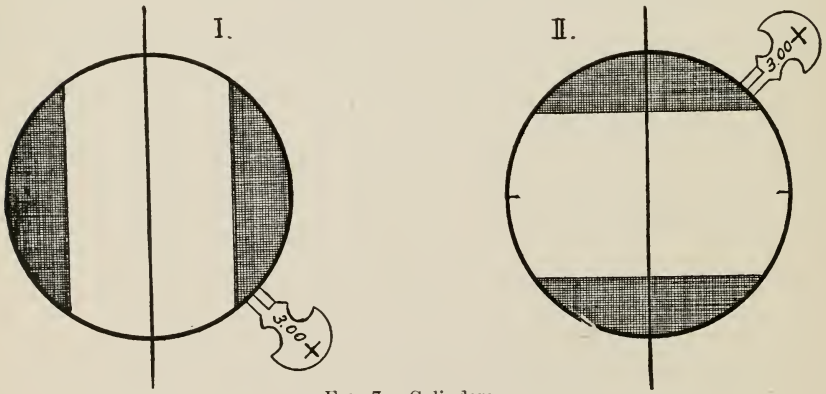

FIG. 7.—Cylinders.

minated object, no matter how near or far away it may be. These lenses are arranged in the trial case in the same way as the plus lenses, their handles being usually stamped with a minus, and also gilded.

CYLINDERS.—These are glasses which are ground in one direction only. Look at the chimney of an argand gas lamp which is cylindrical. The outer surface of this will show the curved surface of a plus cylinder, while the inner surface will show the curved surface of a minus cylinder. One of the surfaces of the cylinders of the trial case is plano. These cylindrical lenses are marked on their handles in the same way as the plus and minus spherical lenses, but in addition their surface for a short distance near the periphery, and parallel to the direction in which there is no curvature, is frosted. This shows the direction of the axis of the cylinder. Referring again to the argand burner chimney, the axis corresponds with the long way of the chimney.

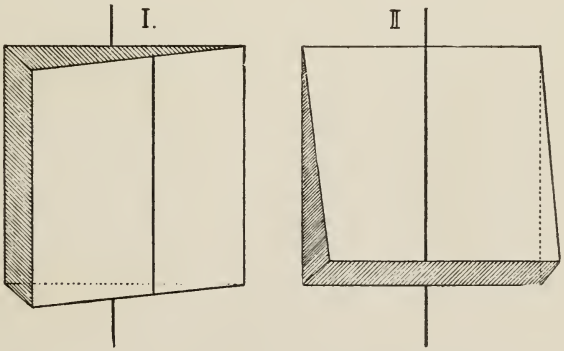

FIG. 8.—Prisms.

PRISMS.—These are wedges of glass which have neither magnifying nor minifying power, their two surfaces being plane. Rays of light in passing through a prism are bent towards the thickest part of the wedge, called the base, the thicker the wedge

the more the bending, while the eye looking through a prism in order to see an object in any selected direction must turn from the direct line of sight towards the sharp edge, or apex, of the prism. Under these circumstances the eye is looking around an angle. Prisms are usually marked with a figure followed by a little triangle to show the number of degrees of arc between the two surfaces of the wedge. There are other ways of marking prisms, called the prism diopter and centrad. They are both scientific in theory, but are not in common use. They will not be discussed here. In many cases there are both circular and square prisms in the trial case, the former to be used with the trial frame and the latter with the fingers.

OPAQUE DISC.—This is a solid piece of metal or rubber, circular in form, to fit the trial frame. It is used to shut off one eye while the other is being tested. All modern optometry is based on testing each eye separately, and while this is being done the other eye should remain open so as not to tire out the patient. The opaque disc produces this result.

GROUND GLASS DISC.—This is used for the same purpose as the opaque disc, but the operator can see the eye through the outside, which in certain cases is an advantage.

PIN-HOLE DISC.—This is the same as the opaque disc, but with one modification. Its center is pierced with a very fine hole through which the patient must look. It has the same effect as cutting down the size of the pupil and this results, in cases of ametropia, in reducing the circles of diffusion formed on the retina, with the result that the outlines of the object looked at become much clearer. It is true that at the same time there is

much loss of light, due to the smallness of the hole, but the clearness of form attained more than offsets this. Any eye that can be improved by this test can always be improved by lenses. There is no exception to the rule.

STENOPEIC DISC.—This is an opaque disc in the center of which there is cut a narrow slit. With it we can test any meridian of the eye. It is used in some cases to detect and correct astigmatism. It has one objection; the size of the pupil of the eye varies with the amount of light which passes through it

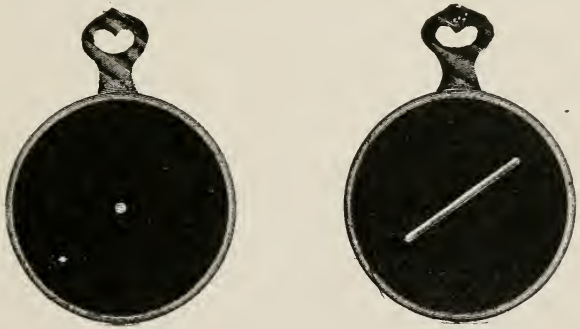

Fig. 9.—Pin-hole Disc and Stenopeic Slit.

to the retina. Since the stenopeic slit cuts off a large part of the light, the pupil will dilate unduly and the peripheral part of the lens will come into play. As this peripheral portion is sometimes of a different power from the center, a false finding may be the result.

MADDOX ROD.—This is used to uncover heterophoria. It consists of a glass rod attached parallel and in front of a sten-

opeic slit. The small glass rod acts as a strong cylinder, thus causing a light, such as a candle, to appear as a long streak about the width of the flame. The difference in the appearance of this from the candle flame itself deceives the eye, and if there is a ten-

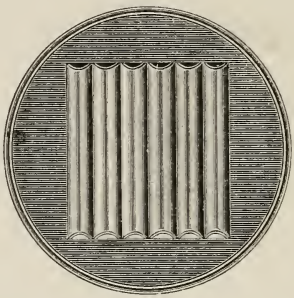

FIG. 10.—Multiple Maddox Rod.

dency to heterophoria the weak muscle will take a position of comfort, since the mind fails to realize that the two bright objects, as seen by the two eyes, one with the rod in front of it and the other not, are one and the same, hence the fusion sense is not in play.

DOUBLE PRISM.—This is a solid piece of glass made in the form of two prisms, base to base. It is placed over the eye so that one-half of the pupil is behind one prism and the other half behind the other prism. This causes the eye to see the light double. By using a red glass over the other eye, or even without any such glass, the patient will see three lights, the upper and lower ones being the two images on one retina, caused by the double prism, and the central one coming from the other eye. The result here is the same as with the Maddox rod. The eye is deceived and the muscles take a position of comfort. The po-

sition which the central light seems to take with relation to the outer ones is the measure of the heterophoria, if such exist.

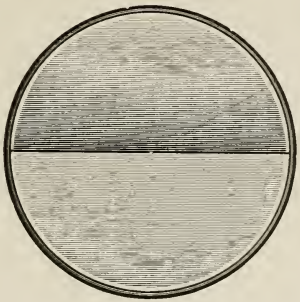

Fig. 11.—Double Prism.

TINTED PLANOS.—These are graded as to the obscurity of the tint, and have been used as sufficient in cases of photophobia, but this practice is decreasing, since photophobia has come to be looked upon as rather a serious symptom. Where the optometrist does prescribe them, the tints should be "smoke," no colors, as the latter are bad for the eyes. It seems to be necessary for the proper functioning of the retina that it should receive white light; that none of the spectrum colors should be missing. Colored glass cuts off some of these colors, smoke tint does not, only decreasing the amount of each color entering the eye.

PLANO LENSES.—There is little call for these in optometrical practice, but sometimes they are used to detect malingerers; for instance, children who want glasses just for looks. These planos are also used in testing eyes of marked acuity, where a lens which is correct will seem to be not as good as the naked

eye because the glass absorbs some of the light and therefore makes the test card apparently not so clear. In these cases when a lens is tried it must be used in conjunction with a plano, so that conditions of illumination of retina may be equal.

COLORED GLASS DISCS.—These are generally red and green. Either may be used in the Maddox rod test and the two can be used together in the FRIEND test for malingerers. In cases of marked hyperphorias the colored glass discs alone, the red or the green, over one eye will be sufficient to show that the condition exists, though the Maddox rod is the best in routine practice for this purpose.

COBALT BLUE GLASS.—This is a special test based on the supposition that if the rays of light from a source of illumina-

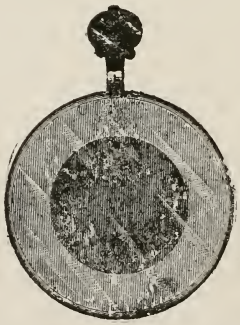

FIG. 12.—Cobalt Blue Glass.

tion are cut down to the red and the blue, the accommodation will relax and thereby permit the ocular condition to be diagnosed by the appearance of the light. The glass used for the purpose is apparently blue, but really allows both red and blue to freely pass

while all the other colors are almost entirely cut off. Since red and blue are unequally refrangible, there will be two images of the flame formed, one blue and the other red, the blue being nearer to the crystalline lens. If the retina of the eye corresponds with the focus of the blue rays then there will be a clear blue image on which is superimposed the red image, but diffused. This will give the appearance of a blue center with a red border. The contrary will be the case if the retina corresponds with the focus of the red rays, while for an intermediate point the two images will both be slightly diffuse and will coincide in size. By these different appearances of the two colors the refraction of the eye is known. Astigmatism is known by the change in the shapes of the two colors. This test is perfectly reliable where there is no accommodation, but otherwise is more or less uncertain.

SCHEINER'S TEST.—This is a very old test. It consists of an opaque disc pierced by two very small holes close together. The eye under test must look through both holes at the same time, the light used being small and bright. The appearance of this light, sometimes single, sometimes double, will give the refraction of the eye. The test is moderately reliable, but difficult to apply, as it is not always certain that the patient is looking through both holes at the same time, and this is necessary for the success of the test.

TRIAL FRAME.—This is a pair of spectacles made especially for testing. By suitable adjustments it may be made to fit any eye, and by its calibration, if this is correct, the size of the spectacles to be worn can be read off. It contains over each eye two or three "cells" or receptacles for holding the lenses and vari-

ous tests from the trial case, one or more of these cells being so arranged that the lens or test placed in it may be revolved. This is

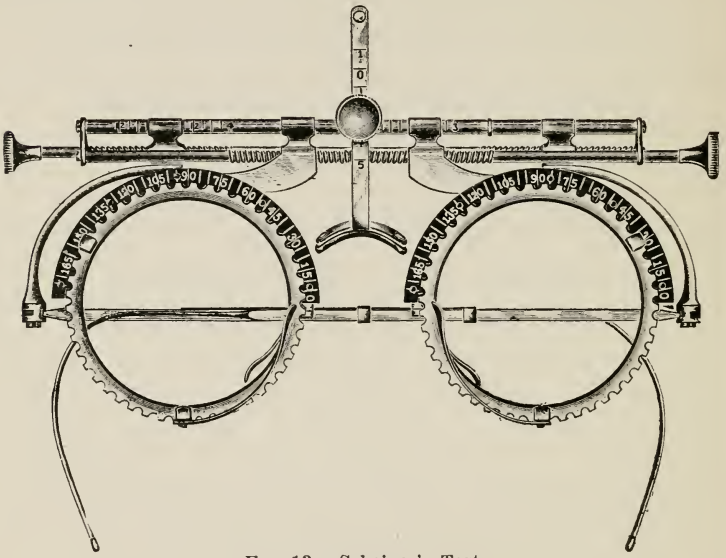

FIG. 13.—Scheiner's Test.
Trial Frame.

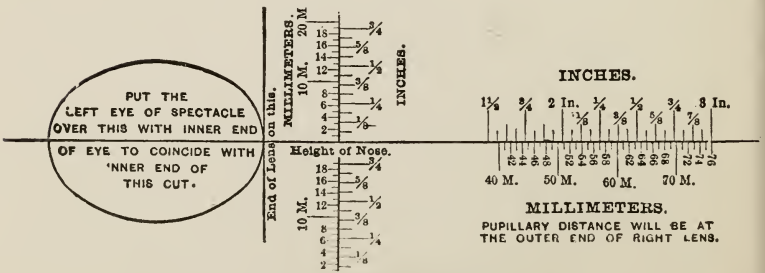

FIG. 14.—Measuring Card.

especially for cylinders. On account of the weight of the trial frame it is an instrument of torture for many people, and its use in these case must be cut down to the smallest space of time possible. It does not usually give satisfaction in taking facial measurements, due to errors in the calibration, to loose joints, and to the fact that very often the round trial frame case lenses cannot be put in the same position that the lenses of the spectacles or eyeglasses are to occupy. Facial measurements are usually and preferably taken with a small ruler divided into millimeters on one edge and thirty-seconds of an inch on the other.

CHAPTER III.

THE CONTENTS OF THE CASE.

The complete trial case for optometrical work usually consists of the following: A graded assortment of bi-convex and bi-concave spherical lenses of from 0.12 diopters to 20 diopters; a similar assortment in plus and minus cylinders; a graded set of prisms, both circular and square, marked by their apex angles, of from 0.12 to 20 degrees or more; a three-cell trial frame; and the following special testing discs: plano lens, tinted plano lenses, Nos. 1 to 6; ground glass disc, opaque disc, pin-hole disc, stenopeic disc, red glass, green glass, cobalt blue glass, Maddox rod and double prism, the latter for muscle tests. Sometimes there are special discs, such as Scheiner's and the cone prism test. Such a case will cost $75.00 or more.

At the other end of the scale we find the pocket case. This contains a limited number of lenses and discs, varying somewhat with the different dealers, but the following will be found to be a good selection: plus and minus spheres in pairs, sizes 0.25, 0.50, 0.75, 1., 1.50, 2., 2.50, 3., and 4 diopters; minus cylinders in pairs, .25, .50, 1., 1.50, 2.25 and 3 diopters; five testing discs; ground glass, pin-hole, stenopeic slit, Maddox rod and red glass. With this outfit and a plain three-celled trial frame, ninety per cent. or more of all cases may be fitted provided the optometrist is a good mathematician, since combinations with so limited an assortment will usually have to be figured. Such a pocket case may be purchased, including the plain three-cell trial frame, for about $15.00.

By adding to the outfit a few high power spheres, plus and minus, the percentage of cases which may be treated will be still higher.

Between the two extremes above mentioned there are all grades of trial cases, at all sorts of intermediate prices. Each one must decide for himself just how far he can go, bearing in mind

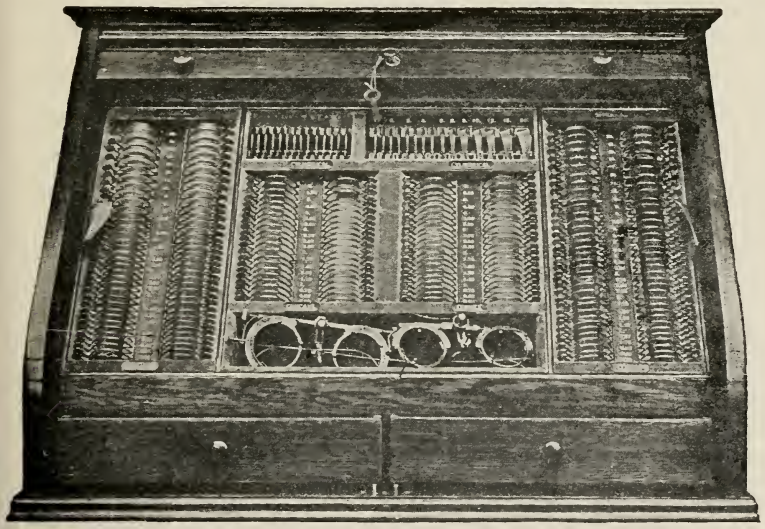

Fig. 15.—Trial Case.

always that the more complete the trial case the more professional it will seem, and the less the optometrist will have to make mathematical calculations.

The method of trial case routine in this work will be so presented that the tests may be made with any variety of outfit within the limits of price stated.

TEST CARDS.

To properly meet all emergencies, the assortment of test cards should be as complete and varied as possible. There ought to be one or more of Snellen's distance test cards, each lettered differently from the others, and if possible a special form of this chart in which the letters on each line are of decreasing size. Also

FIG. 16.—Test Types.

there should be a Snellen's test card for distance in German letters; the E illiterate chart; the picture chart for young children, and the clock dial and other astigmatic charts. For reading distance there should be the Jaeger or the Snellen near chart. For testing the ocular muscles for close work there should be the red and black Maddox near test, to be used with a single prism. This

latter chart is figured for a distance of 10 inches, and it would be well to also have one figured for 16 inches. For taking facial measurements there should be either a properly marked ruler, or else some of the special devises used for this purpose and to be had of the various dealers, or possibly, what is better still, a set of sample frames containing plano lenses and marked with a scratch to show their geometrical centers. For measuring out the glasses

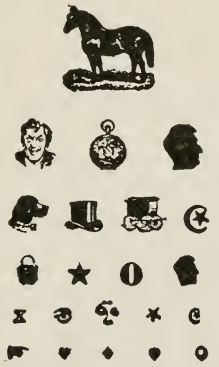

Fig. 17.—Test Types for Little Children.

on their return from the prescription house a protractor card, and for quick work a lens measure, are also needed.

The optometrist who must limit his purchases in these directions can get along, if he has to, with the distance letter chart, a near chart and the clock dial chart.

The usual distance at which trial case tests are made is supposed to be 20 feet. This distance is often stated to be the same practically as infinity, so far as fitting glasses is concerned. This is not correct. If an eye is fitted exactly for an infinite distance,

such as a bright star, by a chart at a distance of 20 feet it is misfitted to the extent of about 1-6 of a diopter, so that it will sometimes be found necessary to allow the nearest to this in the trial case, which is 1-8 D. Then again it is not always possible to get 20 feet of space. In this case the optometrist must get along with less, but should never forget that in the prescription a suitable dioptric allowance is to be made to make the correction right for

FIG. 18.—Pray's Astigmatic Letter Chart.

infinity, the same to be in the form of an increase for minus glasses and a decrease for plus. Where the distance is ten feet or a little less a good plan is to use the reversed letter charts with a mirror. These also may be had of all the dealers.

The distance letter charts should be brightly illuminated. There is a rather general belief that the chart should receive only moderate illumination, so that it may correspond more closely

with natural, every-day conditions. This seems plausible enough, and yet there is no logic in it. In the first place, there is no standard of every-day illumination, and, secondly, what we are primarily seeking to do is to find the dioptric condition of the eye, and this can be best done by bright illumination, the brighter the better within reasonable limits, that is, within the dazzling point. The light which shines upon the distant reading charts should be shaded so that the eye of the patient may receive little light, and this light should also be arranged, as a matter of convenience, so

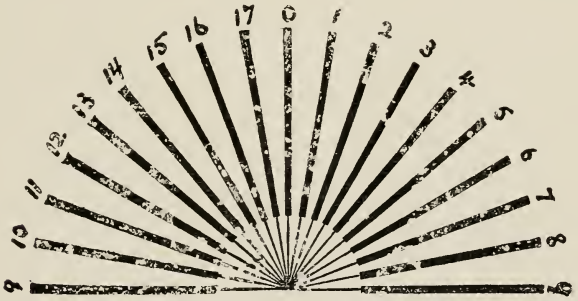

FIG. 19.—Fan Chart for Astigmatism.

that the screen in front of it may be removed and the light itself used for testing muscle imbalance, if so desired. The trial case also should be sufficiently illuminated so that the numbers and marks on the handles of the lenses may be easily read. To see the scale of degrees on the trial frame there should either be a hanging electric light, which could be readily swung into position, or else a mirror could be used to reflect the light to the desired point. The astigmatic clock dial, as well as all other tests for astigmatism, when used, should be exactly at right angles to the line of sight. Where the charts are movable and so arranged that they can be

brought in and out of sight from behind a screen, there should be counterweighted cords running across the ceiling and down to the optometrist's hand. Back of the patient and convenient to the eye of the optometrist there should be small cards which are duplicates of the distant test charts, so that he may know whether his patient is making mistakes or not, without needing to turn and look across the room. When we are testing a patient, we should be relieved of all possible inconveniences, so we may keep our minds constantly on the test itself; and for this reason it is necessary to have everything arranged conveniently. We can often make out without all this special preparation and arrangement of apparatus, but we are also liable at the critical moment to forget some little point which may later cause us considerable annoyance, as well as loss. To do good work in the refracting room, everything should be arranged systematically, and kept so.

CHAPTER IV.

THE PRELIMINARY TESTS.

There are certain points, as many of which as possible ought to be cleared up before the optometrist can advantageously begin to apply his subjective tests with the trial case apparatus. These will be given here in a routine order.

GENERAL INSPECTION.—In the first place, the patient should always remove his or her hat, or else the optometrist may be put to considerable inconvenience. This being done, throw a light on the eye from the side. If the eye is inflamed, or secretions of any kind are present, it will be necessary to politely but firmly refuse to take the case. Sore eyes are usually contagious and some of them are of a very serious nature. In case of slightest doubt, no chances should be taken of carrying infection by means of the trial frame either to the optometrist himself or succeeding patients. If no inflammation or secretions be present, which will usually be true, then the pupillary reaction should be noted. To this end the light should first be pushed back so that the patient's eyes are in darkness, and then it should be brought forward so as to shine directly into the eye, but a little to one side. The pupils of the eyes, under the stimulus of the light, should contract promptly and rapidly. If there is no contraction, or it is very slow, the optometrist will often have the reason at once why there are certain troublesome symptoms, such as photophobia, retinal fatigue, and consequent nervous reflexes.

The cornea and iris and adjoining parts should now be noticed to see if there are any malformations present which would tend to reduce the visual acuity, or, in other words, normal vision.

Some claim that the shape of the head and the face will tell the nature of the optical imperfection, but for this the writer will not vouch. He will simply state here what is claimed in this regard: "Flat face, hypermetropic eye; long face, myopic eye; non-symmetrical face, astigmatism; large and prominent eyes, myopia; small eyes, hypermetropia."

THE HISTORY OF THE CASE.—This is one of the most important points. There are some optometrists who consider themselves belittled if they ask the patient any preliminary questions. They take the ground that it is their place to find out the ocular condition by the use of their optical appliances alone. We can take a little instruction on this point from the physicans. Those of us who are familiar with the work of the medical practitioner and student know how much stress is laid on the "history of the case," and how much time is given to it. There are several things, which, if possible, we should find out by interrogating the patient.

Why does he wish glasses, and has he ever worn them before? If so, for how long and with what results?

What particular ocular symptoms does he notice? Is there dimness of vision, either permanent or temporary?

Does he see double, and in which direction, or do dark spots ever seem to come before his eyes?

Does he have hard work to read, and does the print ever seem to dance or swim?

Are there headache, eyeache, or burning sensations in the eyes, and when?

Are there excessive winking, or flow of tears, or sore-eyes in the morning?

Is a bright light troublesome? Can he see better at night or in the daytime?

Has he ever had eye disease of any kind, and has any one put drops in his eye recently?

To ask categorically all of the above questions would be an unnecessary waste of time, but the patient should be skillfully led to give the information, or as much of it as the inspection of the eyes would seem to make necessary, though there should be no rambling allowed; this being courteously kept in check. Meantime the preliminary tests, as here described, should be going on. Should the patient be churlish, we must get what information we can. Still one more point is essential, especially with presbyopes, and that is to get and measure out the power of the lenses previously worn. Because a patient has a certain amount of either presbyopia or ametropia, it does not follow that full correction should be prescribed. With a knowledge of what the patient has last worn, the question of what to have him wear next is more easily settled. When this information cannot be had, we may unknowingly give the patient what he already has. This he will soon discover when he tries on the new pair and compares them with the old pair at home; then he will return to investigate, which will not always be pleasant. To get the strength of the glasses which he has previously been wearing is just as necessary as it is for a physician to know what medicine the patient has previously been taking. It is true that he can often get along without the knowledge, but he will do better with it. In fact, he might unwittingly give his patient the same old prescription with the same old taste, which he will recognize, with corresponding loss of confidence.

LOOKING IN THE EYE FOR OPACITIES.—This is a rapid test, mainly for the purpose of discovering if there are any signs of cataract. It is made with the regular concave retinoscopic mirror at a distance of about 24 inches from the eye under test. Let the light be about one meter distant; have the patient look *in* a little towards the nose; now reflect the light into his eye, and the red fundus will immediately come into view. If there are any opacities present, either corneal, lenticular or in the vitreous, they will appear as black spots against the red background of the fundus. Where the observer's own eyes cannot accommodate for a distance of 24 inches, he should attach such a lens behind the concave mirror, as will enable him to do so. The object of this is to cut down the corneal reflex to the smallest possible size, and this will be the case when the observer's eye accommodates properly for this image; otherwise it will be blurred and therefore occupy an increased space on his retina, thus hiding, perhaps, some opacity.

Where the pupil of the patient's eye is very small so that the fundus cannot be seen it will be necessary to put a strong plus lens in the trial frame.

THE COVER TEST FOR HETEROPHORIA.—Direct the patient to look steadily at a small light across the room. Hold a card before one eye and watch it from behind the card. Now move the card to cover the opposite eye. Repeat in the reverse direction. Do not be too quick to make the transfer of the card. Wait a few seconds for the eye to become fixed. If, when the card is removed from in front of either eye, there is a jumping movement of the pupil, then there is heterophoria present. Should the cover test develop any motion of this kind, then the following

muscle test should be made: Place over the right eye of the patient the Maddox rod disc, and over the left eye a red glass, unless the Maddox rod is made of red glass, when a green glass should be used instead. At the opposite side of the room have a gas or lamp flame, in front of which is a screen pierced by a hole one inch in diameter. Let the patient sit at a distance from this flame of 9 feet 6 inches. Turn the test in the trial frame until the rod is horizontal. Now cover first one eye and then the other until he has found both lights, one being the one-inch flame colored green and the other a long streak of light. Take away the card altogether and he will see the two forms of light at the same time, though at first he may have a little trouble in this regard, but this soon passes. Now let him describe to you the relative positions of the two lights; how far to one side the streak is, and on which side. Have him express their distance apart in terms of the diameter of the flame. If the distance from center of streak to center of flame is one inch, the diameter of the flame, then he will have heterophoria to the extent that a one-degree prism will correct; that is, for every diameter of the flame that the centers of the two lights are apart, there will be required one degree of prism to correct the heterophoria. This applies, as stated, to a one-inch flame at a distance of 9 feet 6 inches. Make the distance half of this and the flame would have to be but one-half inch in diameter. The optometrist will find that the heterophoria can be discovered by this method in less time than it has taken to explain it. Every one is familiar with an inch, and when the patient is told that the flame is one inch wide, and then asked how many inches the centers of the circle and disc are apart, he will answer correctly.

With the Maddox rod, as stated, over the right eye, if the

vertical streak should also be to the right of the center of the circle of light, then there is esophoria; if to the left, exophoria. Now turn the Maddox rod the other way, vertically, which makes the streak of light horizontal, and test for hyperphoria. The Mad-

FIG. 20.—Before Correction.

dox rod being still before the right eye, if the streak is above the circle, then the right eye looks down, or what is the same thing, the left eye looks up, and we have hyperphoria, while if the streak is below the center of the ring of light, then there is right

hyperphoria. The method of making one inch at a distance of 9 feet 6 inches correspond to a one-degree prism (not a prism diopter) is practically correct to 20 degrees. Above that there is a steadily and rapidly increasing error. It is not absolutely nec-

FIG. 21.—After Correction.

essary to use a green glass; no glass at all will do, but the green glass is easier on the patient's eyes, but where the Maddox rod is white a red glass over the other eye may be used.

VISUAL ACUITY FOR DISTANCE.—Visual acuity depends on several factors. The size of the objects looked at, the

contrast in color between the objects and their surroundings; the illumination; the width of the pupil of the observing eye; the condition of the retina, the optic nerve and the visual centers of the brain; and finally upon the perfectness of the eye as an optical instrument. The standard used for optometrical work is the Snellen's chart when under a bright illumination. This the normal eye should see distinctly at the distances as marked on the chart. The patient should be directed to look at the letters and to read down as far as he can with both eyes, and then with each eye singly. A record is to be made of the result for future comparison. This is with the naked eye. In making this record the following method is used: express the visual acuity as a fraction, the numerator being the number of feet which the patient is distant from the chart and the denominator being the number of the type. 20/20 means that 20-foot type can be read at 20 feet; 10/15 that 15-foot type can be read at 10 feet only; 20/60 partly, means that part of the 60-foot type could be read at 20 feet, but not all the letters. In using the test letter chart it will be noticed that some letters are easier to distinguish than others. The Snellen chart has its letters all drawn to scale, the various parts of the letters being one minute of arc wide, and the letter as a whole occupying 5 minutes of arc. This is the size which a normal eye is supposed to be just able to make out. The letter O is, however, much more readily distinguished, 3 minutes of arc usually being sufficient, while the letter L can often be made out with 2 minutes of arc. Then, again, young people as a rule will see better than normal, say 20/15, while aged persons can rarely do better than 15/20. Where these visual acuities are reached it is sometimes assumed that there is neither myopia nor astigmatism present, unless there should also be present eyestrain or other nervous reflex symptom.

VISUAL ACUITY FOR CLOSE WORK.—This test should be made with the near type, either the Jaeger or Snellen. The patient should be allowed to hold the printed matter at any distance he chooses, and the record should show this distance as well as the smallest size of type that he can read. The two eyes should be tested together first and then each eye separately. Records can be made similar to the following: No. 1 at 20 inches; No. 7 at 8 inches, etc. It would, of course, be better to use the same notation as with the distance chart, but usually the near test charts are not marked on the Snellen basis.

THE FAR POINT IN MYOPIC EYES.—Hold the near type at a distance of six feet or so from the patient and then draw gradually nearer until the letters come clear. If at the distance of six feet the letters are blurred, but come out clear when the chart is brought nearer, then there is myopia present, and the point at which the letters are first clear is the far point for that particular eye.

TO FIND THE NEAR POINT IN ALL EYES NOT TOO HYPEROPIC.—This is found in the same way as in the previous paragraph, excepting that the chart is brought farther forward, until the letters begin to blur again. Where the eyes are myopic this will give us both the far and near point; the far point when the letters come clear and the near point when they begin to blur again. By measuring the distance from the eye in each case and expressing the result as diopters, we can get the amplitude of accommodation, which will be the difference between the two values. Furthermore, the far point itself, expressed in diopters, will be the measure of the myopia. Where

the eye is too hyperopic and presbyopic there will be no actual near point. As a check on the above method, the following may be used: Hold the near test chart close to the eyes and gradually withdraw it. The near point will be the point where the type first comes clear.

THE AUTHOR'S SPECIAL METHOD OF MAKING THE NEAR TEST.—It is not always an easy matter to get the exact near point by means of the near reading chart, for the patient is often liable to read by pseudo-accommodation, the power of reading slightly blurred images. Some patients will pronounce the letters perfectly clear when they may be out of focus as much as a whole diopter. To meet this difficulty the author has devised a special form of near test which is extremely accurate. It consists of a ruler on which there is freely movable a cardboard slider containing three vertical targets, on each of which are drawn three fine black vertical lines, the distance between targets being two inches, though this distance may be made less. To use the device, rest the ruler against the cheek bone under the patient's eye and push the slider up as close to the eye as it will go. Usually the lines on all three targets will be blurred; if not they may be made so by placing a suitable lens before the eye. Next the apparatus should be withdrawn slowly until the lines on the two outer targets become perfectly clear, while the inner one remains blurred. The near point will then be marked by the middle target if the patient is young, and by the point midway between the two if he is presbyopic.

THE PATIENT'S READING DISTANCE.—This does not mean the distance at which he reads when he comes to have

his eyes examined, but rather that point where considering his length of arm and other anatomical points, it will be the right place for him to read when he takes an easy position. The condition of his eyes after fitting will also have something to do with it. It is often assumed that the reading distance should be exactly 13 inches, but for the reasons above stated this is not always the case. Have the patient, with a piece of blank paper in his hand, take that position which is most comfortable for him. Measure this distance from the eye, and make a note of the same.

CHAPTER V.

TESTS FROM THE TRIAL CASE.

When the preliminary tests have been completed the optometrist will usually have a pretty close idea of the patient's ocular condition, and what is left for him to do is to determine that condition with accuracy. To this end he should proceed methodically and according to some chosen system. As to what system shall be followed in routine cases, that is a point on which there is apt to be some difference of opinion. The method given here is the one which the author has found in his own experience to be the most satisfactory in ordinary cases. In the extraordinary ones he has always been prepared to use some other special test,* whichever one seemed to best fit the circumstances of the case. The regular routine, then, will be as follows:

*Subjective Tests for Difficult Cases; Frederick Boger Publishing Co., I Maiden Lane, New York.

ARTIFICIAL FAR AND NEAR POINT.—If the case is one of myopia, as shown by the tests already made, it will not be necessary to test for the artificial far and near point, since the information sought has already been gained. When this is not true, however, a plus 4 diopter spherical lens should be placed in the single cell trial frame over the right eye. (As a matter of routine it is best to always commence with the right eye in all tests and examinations.) The use of the plus 4 diopter lens is not only to get the artificial far point, but also in cases of spasm of the accommodation to unlock the spasm, which will take place in a few moments after the lens has been put in place. Now take the reading chart, or the author's special test, suitably illuminated from a light from behind and a little to one side of the patient. Move the chart away from the eye to be tested until the letters on it are all a blur, and then bring it gradually nearer until the print becomes clear. This will be the artificial far point with a plus 4 diopter lens. Measure the distance from the eyes, convert it into the corresponding dioptric value by dividing into 40, and subtract the result from plus 4 diopters. The answer will be the approximate correction for distant vision. When we put a plus 4 lens before an emmetropic eye, the far point is brought from infinity up to 10 inches or less. If we find with this lens that the artificial point is not 10 inches, then the eye is not emmetropic. If this far point is at 13 inches, which corresponds to plus 3 diopters, then to bring it up the remaining distance to 10 inches, or 4 diopters, we would have to add the difference between plus 3 and plus 4, or plus 1 diopter, which is therefore the approximate measure of the ametropia. If, on the contrary, with the plus 4 diopter lens we find the artificial far point to be at 9 inches, which corresponds to 4.50 diopters, then the eye may be .50 diopters

myopic, though often this will not be true, since the sense of nearness will often induce a certain amount of ciliary spasm.

After the artificial far point has been noted, then the reading chart would be brought still nearer until it blurs again, this time because it has been brought within the nearest point at which it can be made out with all of the accommodation in force; by now moving the chart a little back again the point will be found within which the letters will blur. This is the artificial near point for this particular eye with a plus 4 diopter lens. Note this distance and convert it into the corresponding diopters as before.

A large proportion of the patients will have no difficulty in making out the smallest type on the test chart both for this artificial far and near point, but there will be others who will not be able to do this. Such a result would argue amblyopia, or astigmatism, and note should be made accordingly. To suit these cases, attention should be called to the smallest type that can be made out.

AMPLITUDE OF ACCOMMODATION.—This is the extent to which the ciliary muscle can contract expressed in diopters. To find out how much it is, we deduct the far point from the near point expressed in diopters. For instance, if the artificial far point is found to be at 16 inches and the artificial near point at 5 inches from the eye, then the amplitude of accommodation for near which is usually a little different than for distance will be 5½ diopters, for 16 inches corresponds to 2½ diopters and 5 inches corresponds to 8 diopters, and the difference between the two will be as above stated. The amount of the amplitude of accommodation will vary with the individual and his age. The table by Donders as given below, will apply to most cases, and where the actual

amount in any case as tested out is less, then there will be a suspicion of paralysis of the accommodation, or spasm of accommodation, or a mistake in the age of the patient.

Years.	Amplitude in D.	Years.	Amplitude in D.
10	14.	45	3.50
15	12.	50	2.50
20	10.	55	1.75
25	8.50	60	1.
30	7.	65	0.75
35	5.50	70	0.25
40	4.50	75	0.00

DEVELOPMENT OF THE MERIDIAN OF GREATEST POWER.—The correction of astigmatism is the greatest difficulty which stands in the path of the optometrist. To be certain in this branch of testing requires constant watchfulness. There are two theories as to the way in which an astigmatic eye sees. One is that it accommodates for an intermediate position between the two principal meridians, so as to reduce the difficulty to a minimum, and undoubtedly in some cases this is true. The other is that the eye first adjusts for one meridian and then for the one at right angles. This action is assumed to be extremely rapid, the two images being continually superimposed. If this latter theory is correct, we have a good explanation of two important points; one being why so many astigmatic eyes see so much better than ought to be the case as compared with emmetropic eyes, and the other why small errors of astigmatism produce in some cases such marked eyestrain and reflex symptoms. In any event, no matter which theory is correct, one thing is certain; the accommodation is usually in abnormal play, and unless

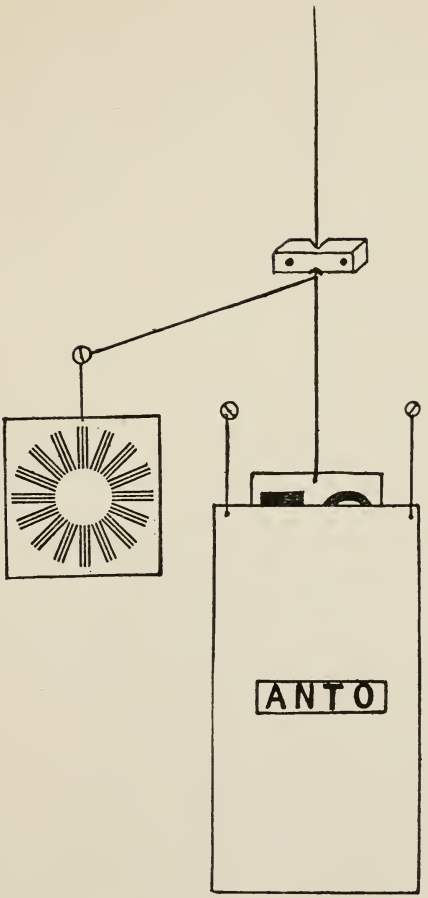

FIG. 22.—An Adjustable Outfit.

we force this to relax we stand little chance of getting the true principal astigmatic meridians. But this is not all. Where the meridians are oblique the prescription is apt only too often to be wrong, either because of an error on the part of the optometrist, or because the glasses are set wrong in the frame, usually the former. A sphero-cylinder with axis 120° will become 60° if turned the wrong side out in the frame. Also it is quite evident that with oblique meridians it will not do for the spectacle eyes to be reversed in the frames, since a right lens with axis 60°, for instance, would not be correct if put in the left eye wire. To show that the optometrist may readily make an error in the case of oblique axes and meridians, let him try the following experiment: Hang the clock dial chart on the wall. On a table on the opposite side of the room place a trial frame just as it would be were it on a patient's face, or it may be placed on some one's face. Now look at the clock dial and select the lines from V to XI; decide with what degree of the trial frame these lines correspond. Now take a ruler, place it over the lines from V to XI; then holding it rigidly in this direction, carry it across the room to the frame and see if it marks the number of degrees decided upon at first as correct. Not every one will get it right, since the lines from V to XI will be found to correspond to 60° and not to 120°, and the lines from IV to X will correspond to 30° and not to 150°.

The first step, then, in the correction of astigmatism is to properly locate the principal meridians, and this cannot be done with any certainty unless the accommodation is relaxed during the test; neither will the result be attained the most smoothly unless the patient receives first such explanation as will give him some idea of what you are trying to do.

Remove the plus 4 diopter lens from before the patient's eye

and let him examine the clock dial chart in his hands. Call his attention to the fact that it is arranged somewhat like a clock. Have him notice that in each direction there are three parallel black lines with two white spaces between. Next estimate his approximate correction for one meter. This is obtained from the artificial far point, as already shown. Put the appropriate lens in the adjustable trial frame, properly centered, turn the letter chart to the wall, hang the clock dial in position, so that it is on a level with the eye to be tested. Ask the patient if he sees all the black lines with intervening white spaces equally distinct, and if all their edges are sharply defined. Do not ask "which line is the blackest." Some people's idea of a black line takes into consideration not only the intensity of the blackness, but the retinal area of its image as well. Now increase the power of the lenses, if plus, or decrease the power, if minus, until all the lines on the chart are blurred. Then take the clock dial from the wall and holding it with the VI to XII lines, exactly vertical, steadily approach the patient. Direct him to tell you which series of lines come out clear the first. These will always show the meridian of greatest power, and by noting the point where they become clear, while the lines in the other direction are still blurred, an idea may be gained of the refractive condition of the eye so far as that meridian is concerned. This is discovered by converting the distance from the eye at which the first lines come clear into diopters, and subtracting the same from the power of the lens which happens to be in the frame.

Place the clock dial back on the wall, and decrease the power of the lens in the frame just enough if a plus; or increase it, if a minus, until the patient again sees the lines of the most defective meridian clearly, while all the others are more or less blurred. Now apply minus cylinders with axes at right angles to the black-

est line, which is always the most defective meridian, until all the sets of radiating lines are alike.

Should the method of procedure as stated above develop no difference in the lines, then there is no appreciable astigmatism in that particular eye.

CHECKING UP ON THE LETTER CHART.—Leaving all lenses in place, remove the clock dial, and direct the patient's attention to the letter chart. Let him read down as far as he can. Now shift the axis of the cylinder, if the previous test has shown astigmatism, from side to side, to see if vision can be improved. It will sometimes happen that the axis is off a few degrees and this procedure will disclose the fact. Next, in cases of medium and high cylindrical corrections, call the patient's attention to the chart as a whole and ask if it seems perfectly rectangular, or whether it appears slanting. Shift the axis of the cylinder again if necessary until this appearance disappears. The usual final test in cases of astigmatism is the ability to best read the smallest letters possible but where rectangular objects seem on the slant, this must be cleared even at the sacrifice of a little acuity.

THE FINAL COMPARATIVE TEST.—The optometrist may be sure that the finding as above given is the right correction so far as the cylinder is concerned, and a succession of tests with intervening periods of time will always, in case of healthy eyes, give the same result. It now remains, however, to get the spheres exactly right. For this we should first change the letter chart, since by this time many patients will have memorized the letters. We are to depend on the sense of contrast, which is an extremely discriminative ocular faculty. Take in one hand a

plano, and in the other a plus .50 sphere. First hold the plano in front of the correction already in place in the frame, wait a few seconds, and then substitute the plus 50, and ask if the latter has caused a slight blur, making sure first, however, that the patient knows what you mean by the word "blur." If the plus 50 does not blur, then take in one hand a plus .50 and in the other a plus 1. and repeat the test. Whenever the increase of .50 as stated above, produces a blur in the chart, then the correction which does not blur is the one desired. Should the plus .50 in the first case blur, then try a plano in comparison with a minus .50, trying the latter first. If necessary compare a minus 1. and a minus .50 in the same way, the minus 1. to be tried first. The reason why a plano should be used as described is that with patients of sharp vision the chart will be pronounced blurred because of a slight dimness caused by the absorption of light by the glass of the lens itself. Glass absorbs light, and with very sharp eyes this fact should be reckoned with. The point will be, perhaps, better realized by the following experiment: Look first through an open window and then through the window glass. The difference will be quite noticeable, no matter how well cleaned the window glass may be. Should the test as made seem to show that even with the plano lens the patient is confusing this dimness with blurring, then a tinted plano may be used to make sure.

In some cases it will be possible to do finer work than the above; that is, where the visual sharpness is unduly acute, the comparative test may be made with differences of .25 D., or even in some cases with .12 D. On the contrary, where the visual sharpness is low, the test may have to be made with differences of power of 1 D. or even more.

CHECKING UP AT THIRTEEN INCHES.—In cases of doubt the following may be added to the above. Combine a plus 3 with the correction for distance already in the frame. This should make the artificial far point at about 13 inches, and if on testing with the near chart for the artificial far point, this does not prove to be the case, then something is wrong; either a mistake has been made, or else latent hyperopia has not been all made manifest.

A DOUBLE CHECK TEST.—When the eye has been fitted, and the full correction for distance is still in place, hold a plus .25 sphere in front of the other lenses in the frame. The type should blur a little. Next with the plus .25 still in place bring in front of it with the other hand a minus .25 sphere. The type should come clear and sharp at once. A plus and minus .50 may be used in the same way for eyes of sub-normal acuity.

THE PIN-HOLE TEST.—Whenever the visual acuity cannot be brought up to normal this test should be used. With it the test letters will never look so bright and clear, but where the subnormal vision is due to optical defects of the eye alone the patient will be able to make out smaller letters on the chart with the pin-hole disc than without it. This is due to the fact that the very small hole in the opaque disc cuts down the angle of aperture so much that diffusion circles on the retina are made extremely small, thus permitting outlines to be more easily followed. Where subnormal vision is due to some physiological or other similar condition, then vision through the pin-hole will not be improved but usually will be made worse. In placing the pin-hole disc before the eye be sure that it is properly centered for the

pupil. It will be found more satisfactory with intelligent patients to have a special holder with a handle for the pin-hole disc, so that the patient may adjust it for himself. Where the visual acuteness is very poor it is a good plan to use the pin-hole disc as the very first test so as to get some idea of the correction by lenses as soon as possible.

CHAPTER VI.

TESTS FROM THE TRIAL CASE (Continued)

THE LENS PRESCRIPTION.—After the dioptric condition of the eyes has been determined, the next question is what to prescribe. The rule followed by some is very simple: Give the full correction and insist that the patient wear it through thick and thin until it becomes acceptable and comfortable. This method takes no account of previous physiological habits. It is based on implicit obedience on the patient's part and often fails, for the reason that the average individual in wearing glasses will reach a decision as to their fitness at the end of a very short time, long before he has had a chance to "get used to them." In deciding this question he has no consideration for anything but his own feelings; he does not compare his old visual acuity with his new; he forgets all about it; but simply knows that the glasses are uncomfortable, which was not the case with the old ones, and hence he rejects them and visits some other optometrist who may not be so fixed in his ideas as to the necessity of always giving a full correction. The scientific fitting of lenses to the eye, with

due regard to acquired and natural ocular functions, is a delicate problem which must be settled separately for each case. The points to be known are the dioptric condition of the eye; the glasses previously worn, if any, and the rules of physiological habits. Especially is this true in medium and high defects and in anisometropia. In the first place, with adults, when astigmatism requires only .50 cylinder for correction, and there are no troublesome symptoms, it will usually be best to disregard the cylinder altogether. In the second place, while no regular rule can be laid down to fit all cases, it will be good routine practice for the first pair of glasses to allow the eye muscles to do a portion of the work, and in the succeeding ones to gradually cut down the amount of this work if the circumstances seem to require it. Where one of the eyes is amblyopic it will sometimes be best to let one eye be fitted and disregard the other, though recently quite a movement has arisen to first correct the best eye with one pair of glasses for ordinary use, and then by special lenses to develop the poor eye, unless the difference between them optically be too great. To this end a special pair of glasses is given in which only the poorer eye is corrected; these practice glasses to be used at regular intervals, say three times daily, the good eye meantime being stopped off. Later, if the poor eye can be worked up to the other in visual acuity with proper correction, a pair of glasses is given correcting both eyes. Again, in cases of anisometropia the question is whether to have one eye for reading and the other for distance, or to try to make both eyes work together. Where the difference between the two eyes does not exceed 1 D., the latter method can eventually be used, but where the difference is greater than 1 D. this method will usually prove impracticable. In any event, if the attempt is made to get

the two eyes to work together the first glasses prescribed should only allow for one-half of the difference of the two eyes, to be followed later by a correction with the full difference. In each case the patient must wear the glasses constantly, or the method will be of no use. One objection to fitting cases of anisometropia in this way is that the patient becomes dependent on his glasses, and if by any mishap they are broken, he will be put to a great deal of annoyance until they are repaired. In the case of high myopes it will be found often that the power of accommodation is more or less diminished from non-use; hence the glasses prescribed should not throw the near point out too far, but the lenses should be made as strong as possible consistent with comfort, and the patient should return later for a stronger pair. Eventually and as soon as possible the full amount of the myopia should be corrected. This is the consensus of opinion of most optometrists and oculists.

THE BINOCULAR TEST FOR DISTANCE.—This, of course, would be omitted in the case of one-eyed patients, of which the optometrist will occasionally have a case. After each eye has been fitted separately, the binocular test should be made. Have the correction selected for distance, in accordance with the previous paragraph, in place. Let the patient look at the smallest letters on the distant chart that he can make out. Now with a pair of plus .25 lenses see if the glasses will be more acceptable with this addition; try the same thing with plus .50 and with minus .25 and minus .50 spheres. It will usually be found that there will be no need to make any change where the eyes are alike. Where this is not true, however, whether because of differences in refractive power or in the axes of meridians of astig-

matism or both, it may be necessary to make some changes in the relative strength. For this purpose use the lenses as given above, also similar cylindrical powers, not over the two eyes together, but over each in turn. For instance, suppose there is anisometropia of 1 D., and suppose we have decided to make a difference in the two glasses of but .50 D., arguing that the eye muscles are to be half relieved of the discrepancy. We may find that we will have to cut the difference down to .25, or, on the other hand, we may be able to go up. Each individual case is a law unto itself in this regard.

GLASSES FOR COSMETIC PURPOSES.—These are given in the case of the blind, either in one eye or both, where the misfortune is noticeable. For a person totally blind, blue or smoke glasses are usually given, but ground glass lenses will be less conspicuous. In the case of a shrunken eye, it is advisable sometimes to fit with a strong glass, which by its magnifying power will make the two eyes look of the same size.

READING LENSES.—The usual method is to estimate the reading correction from the finding for distance on the basis of the age of the patient, and then modify the correction, if necessary, until the patient is satisfied. It is usually assumed that the prescription of glasses for reading is an easy matter, but in altogether too large a proportion of these cases the result in the end is not satisfactory. To correct theoretically a case of presbyopia is simple enough, but to do so to the satisfaction of the wearer of the glasses is quite another matter. Suppose we take the case of an emmetrope, or one who is nearly so. The patient has had to hold the print farther and farther from his eyes, until at last his

arms are too short for the purpose. Under these circumstances he is forced to come at last to the optometrist for glasses. The latter makes his tests and finds the distant correction, asks the patient's age, and then figures the near correction on the basis of a reading and working distance of 13 inches. Apparently the lenses are excellent, the patient is delighted and feels that now his troubles are over, but in a few days he returns. He reports that he can see all right so far as clearness of vision is concerned, but that he simply cannot wear the glasses prescribed; that they are not his fit; that some one has made a mistake. The cause of the trouble is this: He has been fitted for 13 inches. As a result of previous presbyopic experience he has learned, unconsciously, that to see at this short distance he must make a tremendous ocular effort; and in spite of his new glasses he still tries to make it; the result being eyestrain. To relieve the disagreeable symptoms he pushes the print farther back, as he used to, but this makes the type either blurred or not so distinct, and so he brings it back to 13 inches again, regardless of the eyestrain, until he loses patience and comes back to get the "right fit." These symptoms also are accentuated by the strain put upon his convergence, a convergence which he has not used to such an extent for years. So common is this experience in a more or less marked degree, that there are many optometrists who, when asked which are the most difficult cases to fit, will answer promptly "presbyopic ones."

In prescribing glasses for reading and working, to get the greatest satisfaction, there are several points to be taken into consideration; the near point with the distance correction in place; the amplitude of accommodation; the point at which the patient should read to be in the most comfortable position; the point at which he has previously been reading; and most important of all,

the glasses which he has been wearing, if any. The distance at which the patient ought to read ordinarily depends upon his build, unless amblyopia be present, but when he has been reading with arms too far outstretched, it will be necessary at first to select a new point only a little inside of this, even if it does seem too far away. Later he will have to return and get stronger lenses which will bring his reading point to the right place.

Where the presbyopic patient has been wearing reading glasses which have become unsatisfactory, it will usually be because of increasing age and consequent loss of accommodation, though it may be due to incipient cataract or retinal failure. In these cases it is an open question whether it is always necessary to go through the complete routine of examination. If the patient has normal vision and no eyestrain or defects of vision for the working distance, except that his glasses are no longer strong enough, it may not be necessary to do anything more than to add on the + .50 or + 1. diopter required, but where the vision is not normal then a rigid examination is usually best, though if the test with the concave retinoscopic mirror reveals opacities the difficulty is probably cataract, in which event the best and simplest way is to decline the case and strongly advise the eye surgeon.

THE BINOCULAR TEST FOR NEAR.—With the near correction in place have the patient take in his hand the near reading chart and hold it at the reading distance for his case. Now cover first one eye and then the other, to see if one eye sees better than the other. In case one eye is better, alter the correction by an additional plus or minus .25 or more to try to make both eyes alike. Try the same method on the other eye, if necessary. If there should prove to be considerable difference in refraction of

the two eyes try the following: Have the patient watch the smallest letters of the reading chart; then by minus lenses of low power before one eye, or plus lenses of low power before the other (in addition to the correction already in place) see whether there is any difference in the comfortable feeling of the eyes by slight changes in the power of either eye. It will usually be found that where the difference between the eyes is more than .25 D., that this will have to be at least halved. The reason why there should be a difference in the eyes at short distance and not at distance is that the accommodation of the two eyes does not always work in harmony. Where there is a difference between the two eyes at the working distance, and it can not be corrected by lenses, then it is due to an impairment of vision and the patient should be so told, though the difference will often be so slight that no further attention needs to be given to the matter.

THE TEST FOR SPECIAL DISTANCE.—Patients must sometimes be fitted for special distances, as, for instance, musicians and printers; for the former the test chart should be musical notes of various sizes. If these cases are simply presbyopic then the matter is easily arranged, but where there is recent amblyopia due to physiological changes, then trouble may be expected, for it will be found that when the very best correction is in place, whether for type or musical notes, as the case may be, the patient will not see sufficiently well for his purpose. To get a patient of this class to work at closer range than the specified distance is usually impossible, and yet stronger lenses cannot be prescribed unless the work is to be held closer. The optical rule is very simple; the more powerful the lens, the closer the print must be, as is quite clear when we consider magnifying glasses. The patient,

however, as described here, will not accept any such dictum, but demands glasses that will give him what he wants. He will claim that this is what optometrists are for. Of the same general nature as the above is the patient who insists on reading at a certain distance when the condition of his eyes, usually amblyopic, requires that he read at a shorter point. When the optometrist gets a patient of this kind, and cannot convince him of the natural limitations of lenses, he should decline to have anything further to do with the case.

FITTING FOR CLOSER THAN THIRTEEN INCHES.—It sometimes happens in cases of amblyopia, often due to cataract or abnormally small pupils, that the patient must be fitted for a much closer distance than 13 inches. Sometimes it has to be as low as 4 inches or less. It is doubtful as to whether the optometrist should touch these rare cases, but if he does it is better to fit one eye only, so as to avoid extraordinary strain of undue convergence. The writer has fitted a case of this kind, high myopia combined with extensive cataract, for a distance of 2 inches.

CHAPTER VII.

VARIOUS LENSES USED IN GLASSES.

VARIETIES OF LENSES.—The standard lenses for first-class work are periscopic, the concavity in plus lenses being on a minus curve of 1.25 D. of power, the concavity to be placed next the eye. Where there is a minus cylinder present and the axis is

horizontal, the cylindrical side of the lens is placed towards the eye. In glasses for myopia, however, which have a plus curve of 1.25 D., it is the concave side which is placed next the eye. In other cases the lenses are so set that the side which interferes the least with the up and down motion of the eyebrows is on the inside. Occasionally periscopic lenses are unsatisfactory, and it is then necessary to give some other form, such as plano-concave, bi-concave, plano-convex or bi-convex, as the case may be. Why these should be accepted as comfortable, and the others not, is not at all clear. It is usually stated that there is a "glare" with the periscopic form which does not exist with the others, though why so few of the vast number of those who wear the periscopic form should notice this "glare" is a puzzle. Some specialists go so far as to never prescribe periscopics.

LENTICULAR LENSES.—In cases of high ametropia, where the weight of the lenses prescribed becomes an important factor because of their pressure on the nose, "lenticular" lenses are prescribed. These have a small center of the required diop-

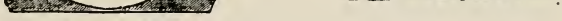

FIG. 23.—Lenticular Lenses.

tric power, while the balance of the lens is ground down to a thin glass plate, thus reducing the weight considerably. It is true that they restrict the field of view, but this does not seem to be noticed by those who wear them.

BIFOCALS.—Where the patient must wear corrections for both far and near vision, two pairs can be described, or else bifocals. There are several forms of these, as may be seen in

any dealer's catalogue, but the form most in use is the "cement," these having proved practically to be the most satisfactory. It takes a patient some little time to get used to bifocals, as the portion corrected for reading is apt to get in the way when the patient looks down. This is especially troublesome when he is going downstairs; in fact, the patient should be cautioned in regard to this. Once, however, accustomed to bifocals, those who wear them are usually pleased and unwilling to take any others.

CLERICAL LENSES.—These are the ordinary style of lenses, periscopic or otherwise, as the case may be, with the tops ground off. They take the place of a bifocal where the patient is emmetropic, or nearly so, so that glasses for distance are not needed. Sometimes, in the case of myopes, they are ground the other way, the bottoms off. Occasionally it is also necessary to cut off the top of lenses to allow them to set under projecting eyebrows. These lenses take their name from the fact that they are used principally by clergymen in the pulpit.

COQUILLES, TORICS AND INVISIBLE BIFOCALS.—These are three forms of lenses of considerable expense, which for those who can afford them are rapidly coming into use. The coquille lens is a shell-shaped glass. For a plus 1. D. it might have a minus curve of 6 diopters on one side and a plus 7 on the other. The outer surface of these lenses, acting as a rather strong convex mirror, produces an effect of brilliancy which gives a peculiar charm and distinctiveness to the face of the wearer.

THE TORIC LENS.—This is similar to the coquille, but corresponds optically to a sphero-cylinder. On one surface there

is a high spherical curve, while on the other the curvature is that of a tore. Such a surface when tested with a lens measure will show different power in different meridians on the same

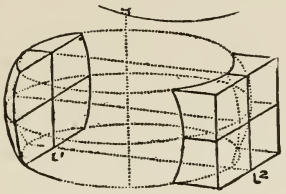

FIG. 24.—Toric Curves.

surface. With both the coquilles and the toric lenses there are sometimes complaints, similar to those in regard to periscopic lenses; hence it is necessary sometimes to give sphero-cylinders instead.

THE INVISIBLE BIFOCALS are recent. They are made of three pieces of glass, two crown glass, and the third flint glass, so made that the wafer which adds the power for near vision is entirely inside the combination. These lenses take the place of the usual bifocal. They will stand rougher usage and make a better appearance.

TINTED LENSES AND PLANOS.—Photophobia or intolerance of light is usually a symptom of some pathological condition, and hence the cases are hardly optometrical. Nevertheless there are cases where the patients demand these glasses, and will have them. Under these circumstances "tinted" glasses will be prescribed. There have been many colors and tints tried for this special purpose in the past, but in view of the nature of the

retina in reference to the waves of light, smoke is the only tint that should be used. The retina is adapted for the reception of all the component parts of white light, and smoke glasses do not cut any of these off, but simply reduce the intensity. On the contrary, tinted glass deprives the retina of the stimulus of the color which it cuts off, or absorbs, and this produces retinal fatigue, and if the wearing of the colored glass is persisted in there will be permanent retinal fatigue. To understand what is meant by retinal fatigue for colors, take a piece of blue paper and place it in the center of a sheet of white paper in a bright light. Stare at the blue paper steadily for about half a minute, then, with the eyes fixed, withdraw the blue paper. In a moment or so a strong after image will appear on the white paper where the blue piece had been placed. This will be of reddish color and very vivid. It means that the white light from the card which falls on that spot of the retina, in this case the macula lutea, where the image of the blue had previously been, is not all seen. We do not see the blue in it, for the eye is tired for blue. What we see is the white with the blue left out, which is reddish. This is the effect that wearing colored glasses will have. Those of us who have gone to the theatre and seen the play of the calcium lights will recall that while the beauty of it was striking, still the return of the while light was always a relief.

PRISMS.—These are prescribed sometimes in heterophoria. A large percentage of cases of heterophoria disappears after the correction of the ametropia. Some authorities claim that all heterophorias are due to refractive errors, and that prisms should never be used; others do not go so far as this, but in any event the first thing to do in heterophoria is to correct the ametropia,

and then wait a few weeks. In other cases the heterophoria is not noticed; it gives no trouble, and therefore no attempt should be made to correct it. Aside from the above-mentioned cases, there are some where the heterophoria persists, and with these prisms should under certain circumstances be prescribed. These cases will not be discussed here.

KEEPING RECORDS.—If the method of partial correction at first, and the gradual increase to full correction later, is followed, as recommended here, then records must be kept, not only of the lenses which are prescribed, but of the dioptric conditions on which such prescriptions are founded. As to the style of record to be kept each one should devise his own. In it there should be all the points that have been described here, including a brief history of the case. Such a record, properly indexed, may save a great deal of future trouble, as well as the necessity of re-examinations.

CHAPTER VIII.

SOME USEFUL INFORMATION.

CHILDREN AND SCHOOL LIFE.—It is an open question as to whether the eyes of many children are equal to the demands of modern civilization. When we consider the age of the world, and then the development of modern printing and its use in schools, we feel that it is going to take many thousands of years before all eyes will be fully altered to fit the continuance of present school conditions. Fine print and sewing are bad enough, especially when they are made part of a kindergarten course, but

when we add to this musical notes written in small type it is not at all strange that eyestrain should be so prevalent.

In the case of books used in schools, there has been a steady improvement, which has, however, for economical reasons, not yet gone far enough. Every school book should be in large type, well spaced, with narrow columns, and not on glazed paper. This will reduce the strain on the vision to the lowest point. But the reform should not stop there. There is the question of desks. Every child should have a desk to fit him, and these are to be had in the market. Some schools use them. Where the desks do not fit, then the body, not being properly supported, the muscles begin to droop; the child to be comfortable comes too near to his work, and eye troubles are the result. In other cases, however, the weariness of the effort is the main point, and the child ceases to be a scholar.

Child nature has been studied a great deal, but the limitations of children's endurance is as yet not one of the courses given to teachers. A child should have frequent periods of rest; a great deal of their work, especially in arithmetic, should be done standing at blackboards on which dustless crayon is used; when small they should have no home tasks at all; in the grammar schools these tasks should be light and few, though beyond that point they seem to be an unavoidable part of modern school life; the light in the schools should be of the right kind and from the correct direction—from the left; under no circumstances should their eyes face the light. The teacher should keep records of the eyesight of the pupils; not scientific records, but simple ones which will not require on her part more than an hour of study to understand and possibly two or three hours of the whole session to make and keep. In the case of those children who fail on the

simple sight tests given, notices should be sent to the parents, and where these notices are not noticed they should be followed up.

MYOPIA—This is the scientific name for near-sightedness. A near-sighted child can see well near by, but not at a distance. Such a child does not like to play with his fellows, as he is always the one "caught." Myopia in school children tends to grow steadily worse. The myopia may develop into cases of disease, and where this is not the case the child is robbed of most of the enjoyment of life. Myopic children are usually unchildishly sober in demeanor.

WHEN SHOULD A CHILD WEAR GLASSES?—In the first place, any child old enough to study, and who does have to study, should wear glasses if his eyes are not normal. This will be shown in several ways: Difficulty in seeing either near or far; pains in the eyes; headaches. School life is an important piece of business, and since almost the only sense used in schools is the eye, and this sense is used to excess, every child's eyes without exception should, before commencing school life, be examined in order to see to what extent he is prepared to take up the work. Knowledge under modern conditions is an absolute necessity, but so is vision, hence no chances should be taken. The idea that all eyes are right and more or less alike is about as true as to say that all people should be of the same height or weight, or color of hair, or state of health.

OVERWORKING THE EYES.—It is strange how some people will overwork their eyes. They will rest their backs when tired, but for a tired eye they have no mercy. They will not

subject their voices to exercise, by screaming, for instance, but they will read on the cars, or read when sleepy, or do fine work, not because they have to, but because they take pleasure in it, though the eyes are rebelling all the time. They will read poor type, and small type, though their eyes are meantime on a continual strain. None of these things ought to be done, as they force the owner of the eyes to wear spectacles sooner than would otherwise be the case, yet every one with normal eyes must wear glasses for reading sooner or later. That is the order of nature. But though no one likes the idea of putting on glasses, still he will do those very things which make the wearing of glasses unduly early a necessity. When such a one is forced to come at last to the optometrist, and wonders why, the reason is simple. He has overworked his eyes and must pay the penalty.

WHEN SHOULD GLASSES BE WORN?—When one does not recognize his friends on the street; when he has to turn the light very high to see to read; when he has to hold the print too far away from his eyes; when he has to hold the print under his nose; when his eyes ache or water! when he has headaches which headache powders won't cure; when things look misty or double; when his eyes trouble him in this way it is time for him to have them examined.

DROPS IN THE EYES.—This is the expression used when atropine or similar substance is put in the eye. Atropine is a powerful poison. It is the alkaloid from belladonna just as morphine is the alkaloid from opium. We should no more think of having this powerful drug put in our eye than we would to take chloroform or ether. Both ether and atropine have their

places, but intelligent people should be slow to consent to their use. It is true that those who make use of atropine belittle its effects; nevertheless it is dangerous, and sometimes produces untoward results.

PARAFFIN INJECTIONS TO IMPROVE THE SHAPE OF THE NOSE.—The eye is an organ with a circulatory system. If the circulation stops, the eye will grow blind. There is danger in the modern practice of injecting paraffin under the skin for cosmetic purposes. Some of the veins from the eye pass down through the base of the nose. In a recent case one of these veins was plugged by a piece of paraffin in injections as above stated, and the result was total blindness in a few hours.

SECOND SIGHT.—Some elderly people regain their vision by what is called second sight. This is an abnormal condition of the lens of the eye, in which it swells and gains magnifying power. In some cases second sight is permanent and a great comfort, but usually it is followed by slowly failing vision, until, if the person lives long enough, there is blindness.

WHAT TO DO WITH AN INFLAMED EYE.

NATURE OF INFLAMMATION.—There are three kinds of eye inflammations: Severe accident, disease, and mechanical irritation due to the presence of some foreign particle. In the first two cases the party should get to a doctor without the slightest delay. In the third case he should be recommended to go to a doctor, but if he will not, ordinary human feeling demands that we do something. Suppose there is lime in the eye, wash the eye

with a solution of vinegar in water, a teaspoonful to a cup of water, or olive oil may be used, whichever can be had the first. In case of burns by acids, use lime water from the druggist or milk is just as good. In severe cases the doctor should have been sent for whether the patient agrees or not, for the injuries are apt to be very serious; and this applies with especial force to pieces of metal which have sunk into the surface of the eye.

DUST OR SAND OR CINDER IN THE EYE.—This is a very common occurrence, and every one should know what to do to help the sufferer. As a matter of fact, dust is getting into the eyes all the time, but tears and winking keep working it out.

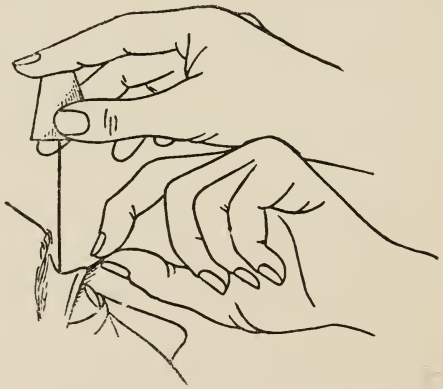

Fig. 25.—Removing the Cinder.

Unconsciously we rub our eyes a great many times every day to get rid of this dust, which gathers, moistened by the natural tears of the eye, at the inner canthus. When, however, something sharp gets into the eye, a cinder, for instance, it is apt to catch

either on the under surface of the eyelid, usually the upper one, or the cornea itself. The old woman's way to get rid of it is to pull out the upper lid, and suddenly insert her tongue into the cavity. Not a very pleasant method, but often very effective. Another way is to run the loop of a horsehair in and draw it across the ball of the eye. This is dangerous, as the eye is apt to be infected. Some druggists sell, or used to sell, what is called "eye-stones," little flat, smooth stones about the size of the scale of a fish, which would be inserted under the upper lid, and which by their movements from place to place, because of the continual turning of the eyeball, would carry out the obstruction. Sometimes when the druggist would be out of eyestones he would fur-

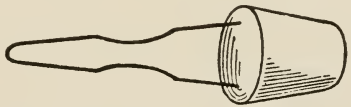

FIG. 26.—A Special Tool for Everting the Eyelid.

nish a small seed for the purpose. Here again there is danger of infection. Still another way is to pull out the lid and blow into the eye. The best way to proceed, however, is as follows: Bring the patient near a bright light; but if the examiner's eyes are presbyopic, and he cannot see well at a close range, say 6 inches, he should put on a pair of spectacles which will permit him to do so, or else use a jeweler's loupe; pull out the lower lid and see if the irritating particle is there; sometimes it is not, as the patient himself will have removed it by the rubbing. Now evert the upper eyelid, stick a hairpin in a cork, catch with the fingers of one hand the edge of the upper lid; touch the center of the lid with the curve of the hairpin of the cork, and turn the eyelid

inside out. The cinder or other matter, if not already out, will be seen at once, and can be removed with the tip of a clean handkerchief or a tuft of absorbent cotton. Remember that the irritation will cause the eye to be painful for some time, even when the cinder has been removed; also that with all your care and searching the particle may be so small that you cannot find it; or it may be so imbedded that you cannot remove it; in either case try to get the patient to go to the doctor for a healing collyrium. He may not take your advice, but at least you have done your duty.

HANDLING LENSES.—Lenses should never be touched by the fingers, as this soils them, which in turn may lead to errors in the subjective tests. They should be kept clean by the use of a fresh cloth each day, and should be removed from the trial case and returned thereto by the handles only.

APPENDIX.

MEASUREMENTS OF THE EYE (*Jaeger*).

Anterior-posterior diameter	24.3 mm.
Horizontal diameter	23.6 mm.
Vertical diameter	23.4 mm.
Diameter of cornea	12 mm.
Average thickness of cornea	1 mm.
Average diameter of pupil	4 mm.
Average diameter of optic nerve through sclerotic	1.5 mm.
Thickness of crystalline lens	3.7 mm.
Diameter of crystalline lens	10.3 mm.

NOTE.—A millimeter (mm.) is very close to 1-25 inch.

APPROXIMATE PERCENTAGES OF VISUAL CONDITIONS IN DARK ROOM.

	Per cent.
Emmetropia	4
Hyperopia	30
Myopia	4
Simple hyperopic astigmatism	10
Simple myopic astigmatism	2
Compound hyperopic astigmatism	45
Compound myopic astigmatism	3
Mixed astigmatism	2
	100

TEST TYPES FROM PRINTERS' FONTS (*Jaeger*).

No. 1—Diamond.
No. 2—Pearl.
No. 3—Nonpareil.
No. 4—Minion.
No. 5—Brevier.
No. 6—Long Primer.
No. 7—Small Pica.
No. 8—Pica.
No. 9—Two-line Brevier.
No. 10—Two-line Long Primer.
No. 11—Two-line Pica.
No. 12—Three-line Pica.
No. 13—Four-line Pica.
No. 14—Five-line Pica.

TEST TYPES (*Snellen.*)

200 ft. 3¾ in. square.
160 ft. 3 in. square.
120 ft. 2¼ in. square.
100 ft. 1⅞ in. square.
80 ft. 1½ in. square.
60 ft. 1⅛ in. square.
40 ft. ¾ in. square.
30 ft. 9-16 in. square.
20 ft. ⅜ in. square.
15 ft. 9-32 in. square.
10 ft. 3-16 in. square.
7½ ft. 9-64 in. square.

RECORD OF CASES.

Name .....

Address .....

Date .....

HISTORY.

Difficulty in seeing far?.....

Difficulty in seeing near?.....

Headaches? .....

Eye-tire? .....

Winking? .....

Flow of tears?.....

Photophobia? .....

Sore eyes in morning?.....

Diplopia? .....

Special symptoms?.....

R. E. Finding:.....

L. E. Finding:.....

R. E. Prescription for distance.....

L. E. Prescription for distance.....

R. E. Prescription for near.....inches.....

L. E. Prescription for near.....inches.....

NOTE.—The above is a record of the case kept by the optometrist for future reference. It is distinct from the prescription order sent to the shop to be filled.

14 DAY USE

RETURN TO DESK FROM WHICH BORROWED

OPTOMETRY LIBRARY

This book is due on the last date stamped below, or
on the date to which renewed.
Renewed books are subject to immediate recall.

LD 21–40*m*-2,'69
(J6057s10)476—A-32

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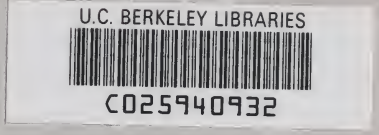
University of California
Berkeley

RE 961
L8
1904